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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/912,558	07/26/2001	Ronald A. Weimer	M4065.0319/P319-A	5990

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EXAMINER

KIELIN, ERIK J

ART UNIT	PAPER NUMBER
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2813

DATE MAILED: 02/24/2003

19

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No

09/912,558

Applicant(s)

WEIMER ET AL.

Examiner

Erik Kielin

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-- The MAILING DATE of this communication appears on the cover sheet with the corresponding address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 07 January 2003.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 13, 14, 16, 17 and 41-43 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 13, 14, 16, 17 and 41-43 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

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DETAILED ACTION

This action responds to Applicant's Amendment filed 7 January 2003.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in-

(1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or

(2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

1. Claims 13, 14, 17, 42, and 43 are rejected under 35 U.S.C. 102(e) as being anticipated by US 6,114,258 (**Miner** et al.).

Regarding independent claims 13, 41, and 42, **Miner** discloses a method of forming a gate dielectric layer on a substrate comprising the steps of

depositing a dielectric film 105 over an active region of a semiconductor substrate 100 to from part of a gate of a transistor (col. 2, lines 20-22), wherein the dielectric film is, *inter alia*, silicon nitride (col. 4, lines 31-36; Figs. 1-3) --as further limited in claim 17; and

subjecting the dielectric film to a wet oxidation with steam provided by heating a mixture of hydrogen and oxygen gases in a rapid thermal process chamber at a temperature greater than 450 °C, particularly 400 °C to 1200 °C (col. 8, lines 13-32) and a specific example of 950 °C (col. 8, lines 44-56) --as further limited by instant claim 14-- and wherein said steam is provided in a ratio of at least 0.005 relative to other gases present in the rapid thermal process chamber (col. 8, line 44 to col. 9, line 20).

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2. Claims 13, 14, 16-17, 41, 42, and 43 are rejected under 35 U.S.C. 103(a) as being unpatentable over the article **Luan**, et al. "Ultra thin high quality Ta₂O₅ gate dielectric prepared by in-situ rapid thermal processing" Electron Devices Meeting, held 6-9 December 1998, IEDM '98 Technical Digest, pp. 609-612 in view of US 6,063,698 (**Tseng** et al.).

Regarding independent claims 13, 41, 42, and 43 **Luan** discloses a method of forming a gate dielectric layer on a substrate comprising the steps of

depositing a dielectric film over an active region of a semiconductor substrate to form part of a gate of a transistor, wherein the dielectric film is tantalum oxide (Ta₂O₅), as further limited in claim 17, having the inherent property of a dielectric constant of "at least about 25" (Introduction), as further limited in instant claim 16; and

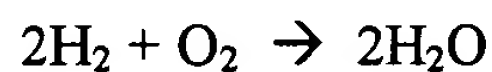
subjecting the dielectric film to a wet oxidation using rapid thermal processing (RTP) and therefore occurring, by definition, in a RTP chamber, at a temperature of 600 °C for a period of about 40-50 seconds (Fig. 1) as further limited in instant claim 15, wherein the wet oxidation environment is formed by heating a mixture of H₂ and O₂. (See whole **Luan** article which is very brief.)

Luan does not teach a wet oxidation temperature in the range of 750-950 °C or a ratio of H₂ to O₂ of about 0.1 to 0.8 (i.e. 10% to 80% H₂).

Tseng teaches a process virtually identical to **Luan** of forming a tantalum oxide gate dielectric 14 on a semiconductor substrate 12 and then wet oxidizing by heating a mixture of H₂ and O₂ to a temperatures of 750-850 °C, wherein the H₂ to O₂ ratio is about 0.03 to about 0.09 (col. 6, lines 58-63) to beneficially "eradicate trap sites 16 and 18" (col. 6, lines 39-57). The **Tseng** teaches that the flow rate of O₂ is 20 liters per minute and that of the diluted H₂ is 10 liters

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per minute, wherein the amount of hydrogen in the mixture is 3% to 9%. (See also Abstract; col. 5, line 54 to col. 6, line 17.) Given that the reaction between H₂ and O₂ is as follows:



Given this stoichiometry, when the hydrogen reacts with the oxygen to form steam in accordance with the teaching in **Tseng**, 9% of the oxygen present will react to form water. The net result is 0.09 times 30 liters per minute which is 2.7 liters per minute of water as steam. Also given the stoichiometry, the total volume decreases because 3 molecules are converted to 2 molecules. This means that there is a net loss of 1/3 times 2.7 liters per minute which is a loss of 0.9 liters per minute. So the total volumetric flow rate is 30 - 0.9 = 29.1 liters per minute. So the final reacted mixture yields steam at 2.7 liters per minute in 29.1 liters per minute of total gas mixture which is 2.7 divided by 29.1 liters per minute which is a ratio of steam 0.093 relative to the total gas mixture which is greater than 0.005.

It would have been obvious to one of ordinary skill at the time of the invention to modify the method of **Luan** to use the temperature and ratio of hydrogen to oxygen taught by **Tseng** in order to beneficially reduce the trap sites and improve the dielectric as taught by **Tseng** and to further reduce the leakage current as taught by **Luan** which is a direct measure of the reduction of trap sites, as taught by **Tseng** (Abstract; col. 4, first paragraph)--especially since the methods are virtually the same.

Further in this regarding, it would be a matter of routine optimization to determine the optimum ratio of hydrogen to oxygen, since **Luan** clearly teaches the use of hydrogen and oxygen therefore expressly indicating some ratio. It has been held that claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they

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produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. *In re Huang*, 40 USPQ2d 1685, 1688(Fed. Cir. 1996). In the instant case, Applicant has not provided any evidence that the claimed ratio provides unexpected results relative to that used in **Luan** in view of **Tseng** --especially since **Luan** only fails to indicate what the ratio of hydrogen to oxygen is, such that one of ordinary skill would be motivated to optimize the ratio to get the best results. Furthermore, the temperature would also amount to routine optimization with consideration to **Tseng** because, it has been held that claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. *In re Huang*, 40 USPQ2d 1685, 1688(Fed. Cir. 1996).

Regarding claim 41, if it is thought that **Luan** does not inherently teach an actual thickness of Ta_2O_5 of greater than 40 Å, then this may be a difference. But **Tseng** teaches that a T_{eq} (*equivalent* thickness relative to an actual thickness of SiO_2) of 20 Å is equal to an actual thickness T_{actual} of 60 Å of high dielectric constant material (e.g. tantalum oxide, Ta_2O_5). (See **Tseng**, col. 4, line 35-43). This indicates that the **Luan** T_{actual} is **necessarily** thicker than the T_{eq} reported because tantalum oxide is a high dielectric constant material. **Luan** teaches a T_{eq} of 13-25 Å wherein the 13 Å T_{eq} is the “thinnest ever reported.” (See **Luan**, first paragraph under the section entitled, “2. Leakage Current”)

Accordingly, it would be obvious for one of ordinary skill in the art, at the time of the invention, to form the tantalum oxide in **Luan** to T_{actual} 60 Å to attain the T_{eq} of about 20 Å reported in **Luan**, as taught also by **Tseng**.

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Response to Arguments

3. Applicant's arguments with respect to all pending claims have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

4. This action is being made non-final to allow Applicant to respond to the new grounds of rejection.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 703-308-4940. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Erik Kielin
February 22, 2003